GEOLOGIC CHARACTERIZATION OF COW POND LAKE

VOLUSIA COUNTY, FLORIDA

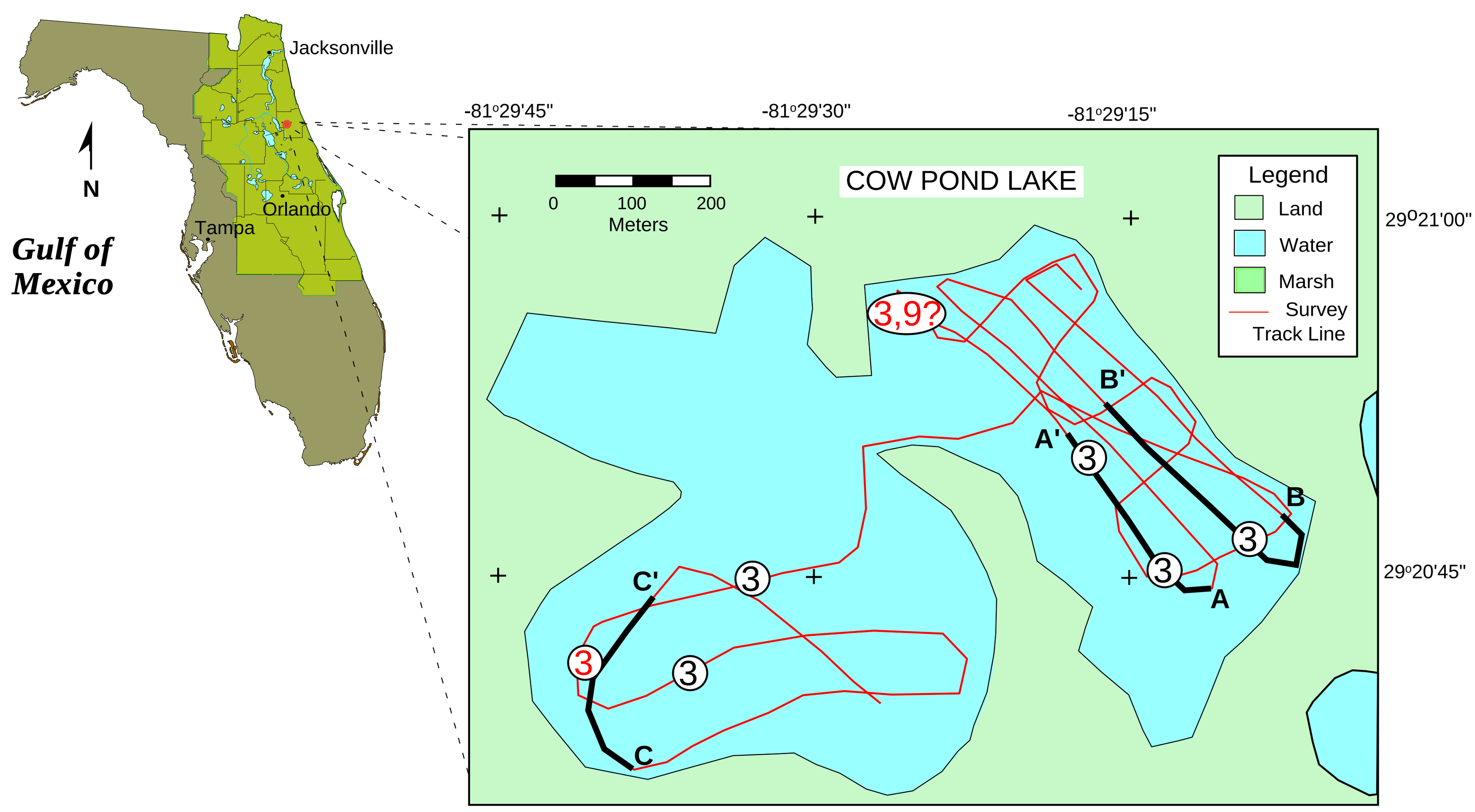
By

Jack L. Kindinger[1], Jeffrey B. Davis[2], and James G. Flocks[1]

1998

[1] Center fo Coastal Geology and Regional Marine Studies
U.S. Geological Survey
St. Petersburg, FL

[2] St. Johns River Water Management District
Palatka, FL



Red numbers indicate deep features

INTRODUCTION

The potential fliud exchange between lakes of northern Florida and the Floridan aquifer and the process by which exchange occurs is of critical concern to the St. Johns River Water Management District (SJRWMD). High-resolution seismic tools with relatively new digital technology were utilized in collecting geophysical data from > 40 lakes and rivers. The data collected shows the application of these techniques in understanding the formation of individual lakes and rivers, thus aiding in the management of these natural resources by identifying breaches or areas where the confining units are thin or absent between the water bodies, the Intermediate aquifer and the Floridian aquifer.

This study was a cooperative investigation conducted from 1993 to 1996 by the SJRWMD and U.S. Geological Survey Center for Coastal Geology (USGS). Since 1989 there have been technical and hardware advances in the digital acquisition of high-resolution seismic data. The primary objective of this cooperative was to test newly developed digital high-resolution single-channel marine seismic continuous-profiling-equipment (HRSP) and apply this technology to identify subbottom features that may enhance leakage from selected lakes and the St. Johns River. The target features include: (1) identifying evidence of breaches or discontinuities in the confining units between the water bodies and the aquifer, and; (2) identifying areas where the confining unit is thin or absent.

METHODS

In cooperation with SJRWMD the USGS acquired and upgraded a digital seismic acquisition system. The Elics Delph2 High-Resolution Seismic System was acquired with proprietary hardware and software running in real time on an Industrial Computer Corp. 486/33 PC. Hard-copy data was displayed on a gray scale thermal plotter. Digital data was stored on a rewritable Magneto-Optical compact disk. Navigation data was collected using a Trimble GPS or PLGR (Rockwell) GPS. GeoLink XDS mapping software was used to display navigation.

The acoustic source was the Huntec Model 4425 Seismic Source Module and a catamaran sled with an electromechanical device. Occasionally, an ORE Geopulse power supply was substituted for the Huntec Model 4425. Power was set at 60 joules or 135 joules depending upon conditions. An Innovative Transducers Inc. ST-5 multi-element hydrophone was used to detect the return acoustical pulse. This pulse was fed directly into the Elics Delph2 system for storage and processing.

Forty-four line-km of HRSP data was collected from Lake Disston. A velocity of 1500 meters per second (m/s) was used to calculate a depth scale for the seismic profiles. Measured site specific velocity data is not available for these sites.

These surveys were conducted in part to test the effectiveness of shallow-water marine geophysical techniques in the freshwater lakes of central Florida. Acquisition techniques were similar but modifications were necessary. Data quality varied from good to poor with different areas and varying conditions. As acquisition techniques improved so did data quality in general. In many areas an acoustic multiple masked much of the shallow geologic data.

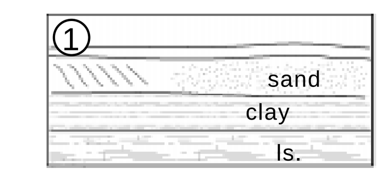
PHYSIOGRAPHY

Cowpond Lake is located along the Crescent City Ridge in the northwestern Volusia County. The ridge is described by Brooks, 1981, as a complex of Plio-Pleistocene sand hills resting directly on the Floridan Aquifer. The active karst development of the uplifted limestone makes this area a principle recharge area for the aquifer, as evidenced by the numerous lakes in Volusia and Lake counties. The Crescent City Ridge bisects the marshy lowlands of the Crescent Lake Basin to the east and the St. John's River valley to the west. The ridge trends southeast-northwest, along with Deland Ridge to the south. Ridge heights reach 100 feet above sea level, lake levels at the time of the survey were about 40 feet NGVD. Cowpond's irregular shape gives it over 5 kilometers of shoreline with an area of only 0.6 km.

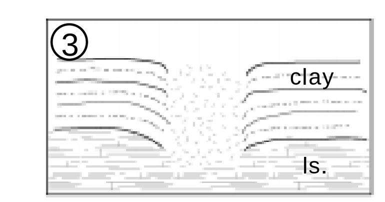
GEOLOGIC CHARACTERIZATION

The quality of the seismic profiles obtained from Cowpond Lake is generally poor. A strong bottom reflector leads to multiples seen throughout the data that obscure some of the record in the deeper portions of the lake. The record is also partially obscured in areas where the lake bottom nears the surface (profile C-C'). Areas above the first multiple show sediment fill (Feature 1 profile C-C') and evidence of near surface subsidence (Feature 3, profile A-A'). The type 3 features extend to depth in the profiles and occur in numerous, constrained areas throughout the lake. Figure 1 shows the locations of the subsidence features, relative to areas of deeper lake bottom. The figure shows that the lake is comprised of small solution/subsidence features rather than one predominant subsidence as seen in other lakes. Most of the type 3 reflection patterns seen in the lake extend to depth from the near surface. Two areas of the lake, however, show deeper solution/subsidence type features (red numbers, index map) that do not extend entirely to the surface. These features may have evolved on a different time scale (earlier and infilled, or later and not fully developed) or hydrologic regime than the other type 3 features. Throughout the seismic profiles, segments of a strong reflector can be seen at depth where the record is not obscured (blue lines). These reflectors may represent the karst surface of the Ocala Limestone. Interpretations of gamma logs from wells in the vicinity (wells P-0416, V-0346, V-0184, gamma log sheet #) infer the top of the Ocala Limestone to range from -50 to -75 feet below sea level. The depth corresponds to 36 to 46 milliseconds below the lake surface, using an averaged sound velocity of 1500 m/s. This correlates with the strong reflector seen in profile C-C'. The material above the Ocala could be the sands and clays of the Hawthorn formation and subsidence fill from the Plio-Pleistocene ridge sediments.

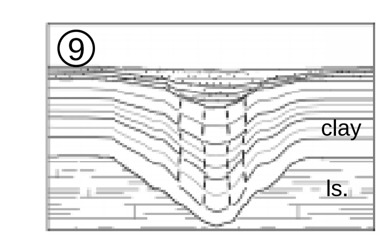
EXPLANATION



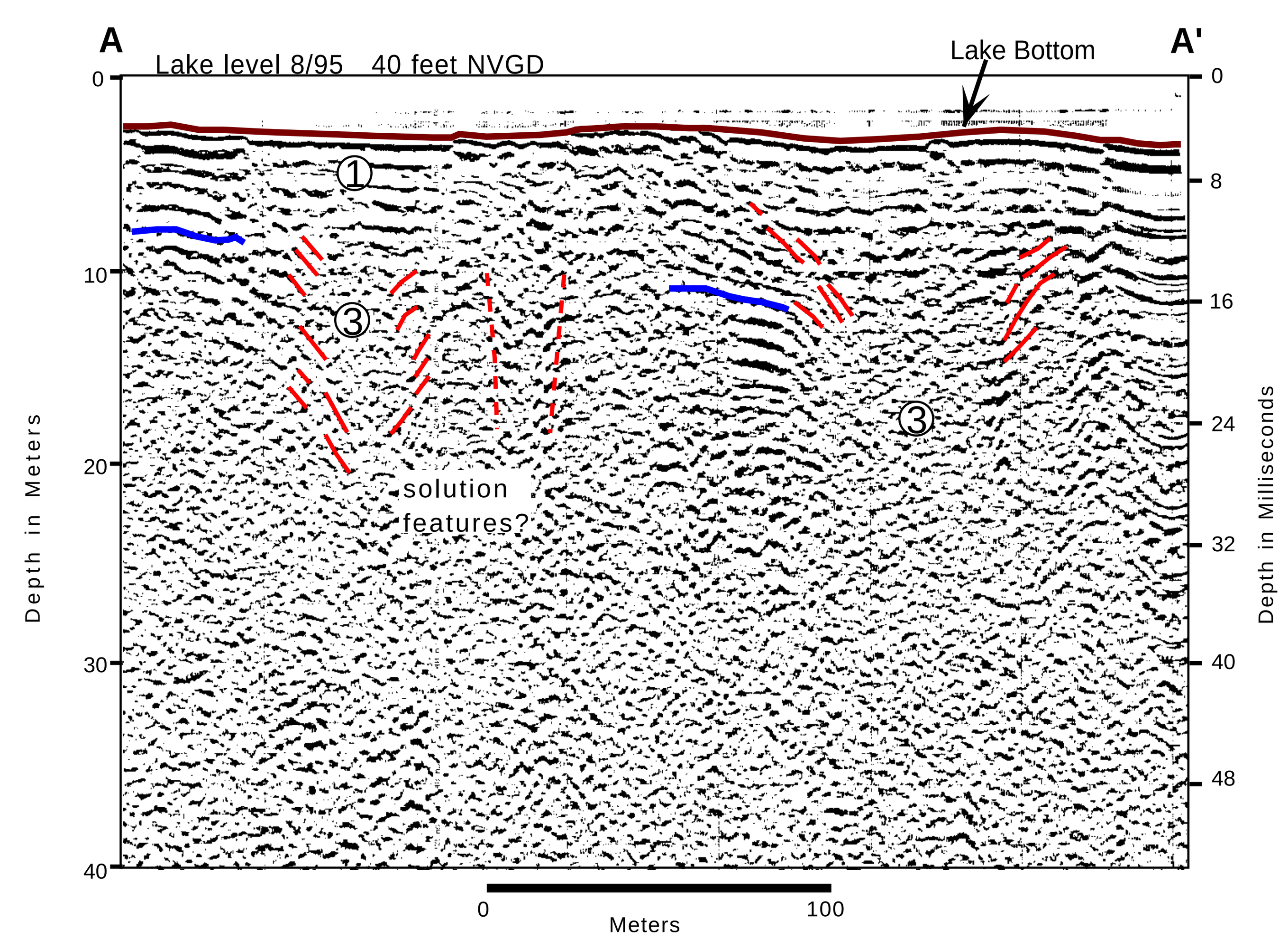
Undisturbed section, with or without upper non-reflective sand layer. Sand layer may show reflection where cross bedding from original deposition (fluvial or aeolian) exits. Clay layers are mostly intact.

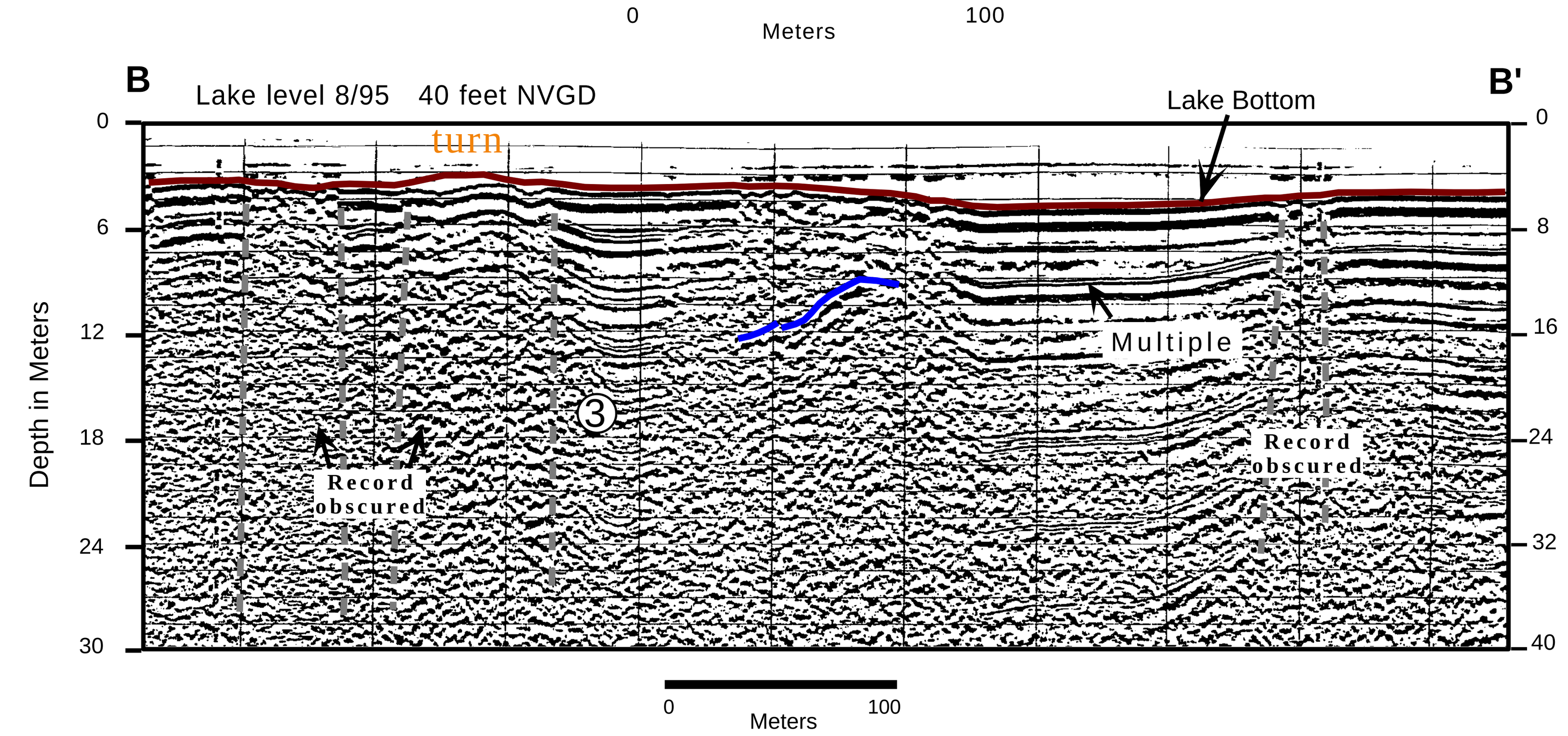


Horizontal reflectors continuous on either side of a central non-reflective zone. Horizontal layers bend downward towards the central zone. These features are representative of filled collapse sinks. The size may range from tens of meters to kilometers across a lake basin.



Low- to mid-angle subsidence depressions. Parallel reflectors have undergone displacement and rotation, creating stress fractures and faulting within the depression. The subsidence may or may not be filled with overburden.





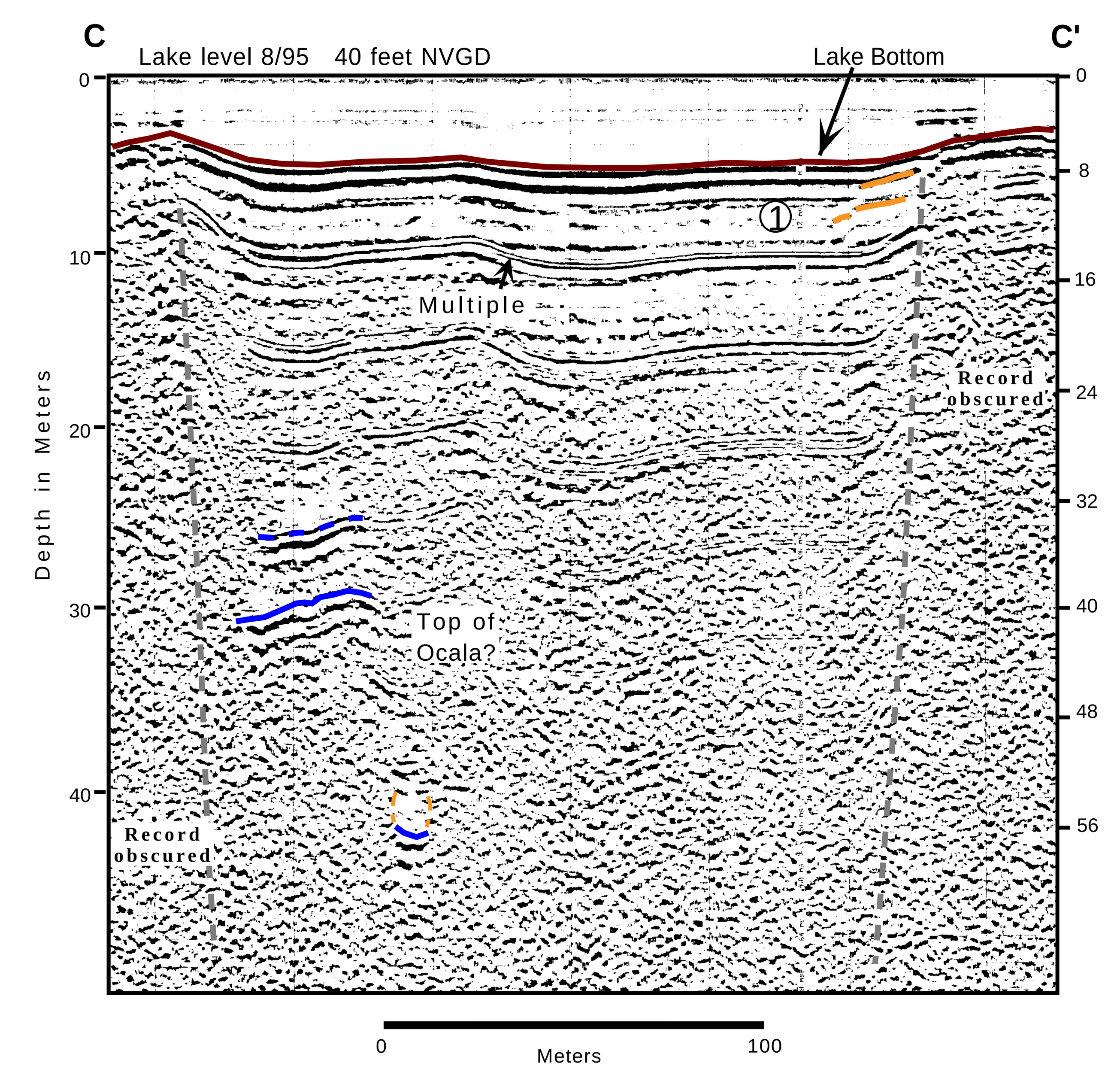


Figure 1. Distribution of features noted from seismic profiles.